PROCEEDINGS

OF

THE ROYAL SOCIETY.

1834–1835. No. 19.

December 18, 1834.

SIR BENJAMIN COLLINS BRODIE, Bart., Vice-President, in the Chair.

The Rev. John Barlow, M.A.; Rev. James William Bellamy, B.D.; William Brockedon, Esq.; Thomas Galloway, Esq., M.A.; Bisset Hawkins, M.D.; Col. Andrew Leith Hay, K.H., M.P.; Francis Kiernan, Esq.; George Lowe, Esq.; Richard Owen, Esq.; Benjamin Phillips, Esq.; Richard Saumarez, Esq.; Charles John Kemys Tynte, Esq., M.P.; and John Gardnor Williamson, Esq.; were elected Fellows of the Society.

The reading of a paper, entitled, "On the Proofs of a gradual Rising of the Land in certain parts of Sweden." By Charles Lyell, Esq., F.R.S., was resumed, but not concluded.

January 8, 1835.

The REV. PHILIP JENNINGS, D.D., Vice-President, in the Chair.

On the Proofs of a gradual Rising of the Land in certain parts of Sweden. By Charles Lyell, Esq., F.R.S.

An opinion has long been entertained that the waters of the Baltic and even of the whole Northern Ocean, have been gradually sinking; and the purport of the present paper is, to communicate the observations which the author made during the summer of 1834, in reference to this curious question. In his way to Sweden he examined the eastern shores of the Danish islands of Moën and Seeland, but neither there, nor in Scania, could he discover any indications of a recent rising of the land; nor was there any tradition giving support to such a supposition. The first place he visited, where any elevation of land had been suspected, was Calmar; the fortress of which, built in the year 1030, appeared, on examination, to have had its foundations originally laid below the level of the sea, although they are now situated nearly two feet above the present level of the Baltic. Part of the moat on one side of the castle, which is believed to have been formerly filled with water from the sea, is now dry, and the bottom covered with green turf. At Stockholm, the author found many striking geological proofs of a change in the relative level of the sea and land, since the period when the Baltic has been inhabited by the

Testacea which it now contains. A great abundance of shells of the same species were met with in strata of loam, &c., at various heights, from 30 to 90 feet above the level of the Baltic. They consist chiefly of the *Cardium edule*, the *Tellina baltica*, and the *Littorina littoreus*; together with portions of the *Mytilus edulis*, generally decomposed, but often recognisable by the violet colour which they have imparted to the whole mass. In cutting a canal from Sodertelje to lake Maelar, several buried vessels were found; some apparently of great antiquity, from the circumstance of their containing no iron, the planks being fixed together by wooden nails. In another place, an anchor was dug up; as also, in one spot, some iron nails. The remains of a square wooden house were also discovered at the bottom of an excavation made for the canal, nearly at a level with the sea, but at a depth of 64 feet from the surface of the ground. An irregular ring of stones was found on the floor of this hut, having the appearance of a rude fire-place, and within it was a heap of charcoal and charred wood. On the outside of the ring was a heap of unburnt fir wood, broken up as for fuel; the dried needles of the fir and the bark of the branches being still preserved. The whole building was enveloped in fine sand.

The author next notices several circumstances regarding buildings in Stockholm and its suburbs, from which he infers that the elevation of the land, during the last three or four centuries, has not exceeded certain narrow limits. At Upsala he met with the usual indications of a former elevation of the sea, from the presence of littoral shells of the same species as those now found in the Baltic. Certain plants, as the *Glauca maritima* and the *Triglochin maritimus*, which naturally inhabit salt marshes bordering the sea, flourish in a meadow to the south of Upsala; a fact which corroborates the supposition that the whole of the lake Maelar and the adjoining low lands have, at no very remote period of history, been covered with salt water.

The author examined minutely certain marks which had at different times been cut artificially in perpendicular rocks, washed by the sea, in various places; particularly near Oregrund, Gefle, Löfgrund, and Edsk̈ösund; all of which concur in showing that the level of the sea, when compared with the land, has very sensibly sunk. A similar conclusion was deduced from the observations made by the author on the opposite, or western coast of Sweden, between Uddevalla and Gotenburg; and especially from the indications presented by the islands of Orust, Gulholmen, and Marstrand.

Throughout the paper a circumstantial account is given of the geological structure and physical features of those parts of the country which the author visited: and the general result of the comparison he draws of both the eastern and western coasts and their islands, with the interior, is highly favourable to the hypothesis of a gradual rise of the land; every tract having, in its turn, been first a shoal in the sea, and then, for a time, a portion of the shore. This opinion is strongly corroborated by the testimony of the inhabitants, (pilots and fishermen more especially,) of the increased extension of the land, and the apparent sinking of the sea. The rate of elevation, however, appears to be very different in different places: no trace of such a change is found in the South of Scania. In those places where its amount was ascertained with greatest accuracy, it appears to be about three feet in a century. The phænomenon in question having excited increasing interest among the philosophers of Sweden, and having especially excited the attention of Professor Berzelius, it is to be hoped that the means of accurate determination will be greatly multiplied.

January 15, 1835.

JOHN WILLIAM LUBBOCK, Esq., M.A., V.P. and Treasurer, in the Chair.

Second Essay on a general Method in Dynamics. By William Rowan Hamilton, Esq., Andrew's Professor of Astronomy in the University of Dublin, and Royal Astronomer of Ireland. Communicated by Captain Beaufort, R.N., F.R.S.

This essay is a sequel of the one which appeared in the last volume of the Philosophical Transactions, and which contained a general method for reducing all the most important problems of dynamics to the study of one characteristic function, or one central or radical relation. It was there remarked that many eliminations required by this method might be avoided by a general transformation, introducing the time explicitly into a part (S) of the whole characteristic function (V); and the first object of the present essay is to examine and develope the properties of this part (S), which the author designates by the term *Principal Function*. This function is applied by the author to problems of perturbation, in which he finds it dispenses with many laborious and circuitous processes, and furnishes accurate expressions of the disturbed configurations of a system by the rules of undisturbed motion, if only the initial components of velocities be changed in a suitable manner. Another manner of extending rigorously to disturbed, the rules of undisturbed motion, by the gradual variation of elements, in number double the number of the coordinates or other marks of position of the system, which was first invented by Lagrange, and was afterwards improved by Poisson, is considered in this second essay under a form rather more general; and the general method of calculation which has already been applied by the author to other analogous questions in optics and in dynamics, is now applied to the integration of the equations which determine these elements. This general method is founded chiefly on a combination of the principle of variations with those of partial differentials, and may furnish, when matured, a separate branch of analysis, which may be denominated the *Calculus of Principal Functions*. When applied to the integration of the equations of varying elements, it suggests the consideration of a certain *Function of Elements*, capable of being variously transformed, and which may be either rigorously determined, or at least approached to, by a corollary of the general method. With a view to illustrate these new principles, and more especially those connected with problems of perturbation, they are applied, in this essay, first, to a very simple example, suggested by the motions of projectiles, the parabolic path being treated as the undisturbed; and secondly, to the problem of determining the motions of a ternary or multiple system, with any laws of attraction or repulsion, and with one predominant mass. This latter problem, which was touched upon in the former essay, is here resumed in a new manner, by forming and integrating the differential equations of a new set of varying elements, entirely distinct in theory (though little differing in practice) from the elements conceived by Lagrange; and having this advantage, that the differentials of all the new elements for both the disturbed and disturbing masses may be expressed by the coefficients of one disturbing function.

An Account of the Eruption of Mount Etna in the year 1536, from an original cotemporary document, communicated in a letter to J. G. Children, Esq., Secretary of the Royal Society. By Sir Francis Palgrave, K.G.H., F.R.S.

Record Office of the Treasury, Chapter House,
Poets' Corner, Westminster, Jan. 14, 1835.

Amongst various shreds and fragments of the correspondence from Italy during the period that Henry VIII. was negotiating with the Italian princes, is a document of a very different nature from the rest, being an extract from a letter written by the Barone di Burgis, dated at Palermo, 10th of April 1536, and giving an account of the then recent eruption of Mount Etna.

" Die xxiij. Martii, M. D. xxxvi., nocte, Mons Ethna qui nunc Mongibellus vocatur; facto, orientem versus, ostio, emisit materiam igneam, quæ ad instar fluminis vagata est per octo miliaria in longitudine, et per unum miliare in latitudine; ejus vero altitudo erat palmarum duodecim. Eâdem nocte ignis extinctus est, et ubique remansit nigra materies prædictæ altitudinis duodecim palmarum. Ignis totam liquefecit nivem, quæ ad instar rapidi torrentis tanto impetu defluit, ut domus, arbores, et quicquid obviam esset secum traheret.

" Sequentibus autem diebus scissa sunt alia ostia numero tredecim, quæ miro strepitu ignem evomebant ad instar bombardarum; longeque ab his per unum miliare cadebant ingentia saxa, quorum aliquot judicata sunt ponderis ultra quindecim cantanorum. Post strepitum sequebatur odor sulphureus per aliquot miliaria in locis circumvicinis. Tantus erat impetus hujus igneæ materiei, ut arbores prostraret et evelleret antequam eas tangerat, sique veterem materiem incendiorum præteritorum sæculorum, offendebat, eam denuo incendebat.

" Ex quolibet ostio profluebant amplissimi rivi, qui aliquo in loco suâ latitudine unum miliare occupabant, erantque altitudine duodecim palmarum.

" Duravit hic ignis per sex dies, et singulâ quâque nocte aspiciebatur in cacumine montis, ignis; die vero, fumus.

" Sed cognosci nequibat quem faceret effectum, quia illuc ascendere non licebat propter relictam materiem incendii."

On the Electrical Relations of Metals and Metalliferous Minerals, By R. W. Fox, Esq. Communicated in a letter to Davies Gilbert, Esq., F.R.S.

The author states that he has ascertained that the crystallized gray oxide of manganese holds a much higher place in the electro-magnetic scale than any other body with which he has compared it, when immersed in various diluted acids, and alkaline solutions: he also gives a table of the order in which other metals and minerals stand in this respect. When employed in voltaic combinations he found that on being so arranged as to act in opposition to one another, the direction of the resultant of their action, as indicated by the deflection of the magnetic needle, did not coincide with the mean of the directions of the needle when under the separate influence of each. Hence he infers that the needle is not a true index of the electricity transmitted; and that electro-magnetic action does not depend on a continuous electric current. He conceives, therefore, that the phænomena are better explained on the hypothesis of pulsations which he formerly advanced. A galvanometer of a new construction is employed by the author for weighing the deflecting force of these electrical impulses.

On the Circulation of the Blood in Insects. By John Tyrrell, Esq., A.M. Communicated by P. M. Roget, M.D., Secretary to the Royal Society.

The observations on the circulation of the blood in insects, which is a discovery of comparatively recent date, have been made almost exclusively on insects in the larva state; but the author of the present paper details a variety of observations of the same fact in insects which had arrived at their last or perfect stage of development. Among the *Myriapoda*, the circulation was traced in the *Geophilus*, and still more distinctly in the *Lithobius forficatus*. The author also detected the circulation, by the motion of globules, through the nervures of the wings of various perfect insects, namely, of some species of the *Hemerobius*, *Panorpa*, *Phryganea*, and *Ephemera*; and particularly in the *Musca domestica*, or common house-fly. The paper is accompanied by drawings of the appearances described.

January 22, 1835.

JOHN WILLIAM LUBBOCK, Esq., Vice-President and Treasurer, in the Chair.

A paper was read, entitled, "Notes on the Temperature of the Air and the Sea, &c., made in a Voyage from England to India, in the Ship Hoogly, Capt. Reeves, in the year 1833." By Alexander Burnes, Esq., F.R.S.

The observations contained in this communication are recorded in a tabular form, and show that the variations of the temperature of the sea accord very closely with those of the air, in all the latitudes which the author traversed in this voyage.

A paper was then read, entitled, "Remarks on certain Statements of Mr. Faraday, contained in the Fourth and Fifth Series of his Experimental Researches in Electricity." By John Davy, M.D., F.R.S.

Dr. Davy complains that Mr. Faraday has, in the paper referred to, made certain statements with respect to the opinions of Sir Humphry Davy relative to the conducting powers of dry nitre, and caustic potash and soda, when in fusion by heat, and also with regard to other matters connected with voltaic electricity, which are not correct; and vindicates Sir Humphry Davy from the charge of want of perspicuity in the statement of his views of these subjects.

A Note by Mr. Faraday on the preceding Remarks by Dr. Davy was then read, in which he replies to the charges there brought forward, and justifies those statements, the accuracy of which had been impugned by Dr. Davy.

January 29, 1835.

WILLIAM THOMAS BRANDE, Esq., V.P. in the Chair.

The reading of a paper was commenced, entitled, "Experimental Researches in Electricity. Ninth Series." By Michael Faraday, Esq., D.C.L., F.R.S.

February 5, 1835.

The Rev. PHILIP JENNINGS, D.D., Vice-President, in the Chair.

Albert William Beetham, Esq.; John Edye, Esq.; John Hamett, M.D.; John Greathed Harris, Esq.; the Rev. Henry Tattam, M.A.; and Martin Tupper, Esq.; were elected Fellows of the Society.

Mr. Faraday's paper, entitled, "Experimental Researches in Electricity. Ninth Series," was resumed and concluded.

In the series of experiments which are detailed in this paper, the author inquires into the causes of some remarkable phænomena relating to the action of an electric current upon itself, under certain circumstances, whereby its intensity is highly exalted, and occasionally increased to ten, twenty, or even fifty times that which it originally possessed. For the production of this effect, the principal condition is that the current traverse a considerable length of a good conductor, such as a long wire; more especially if this wire be coiled in the form of a helix; and the effect is still farther augmented when this helix is coiled round a cylinder of soft iron, constituting an electro-magnet. The evidence on which these conclusions are founded is the following. If an electromotor, consisting of a single pair of zinc and copper plates, have these metals connected by a short wire dipping into cups of mercury, the electric spark consequent upon either forming or breaking the circuit is so slight as to be scarcely perceptible; but if a long wire be employed as the medium of connexion, a bright spark is obtained on breaking the contact. If the wire be coiled in a helix, the spark is still brighter; and if a core of soft iron be placed within the helix, the spark, at the moment of disjunction, is more brilliant than in any of the former cases: and the higher intensity of the current is also manifested by the occurrence of a shock, at the same moment, to a person who grasps with wetted hands the two ends of the wire; whereas no such effect, nor even any sensible impression on the tongue, is produced by the electromotor, when a short wire is employed.

All these effects of exaltation are produced at a time when the actual current of electricity from the electromotor is greatly diminished; as the author shows by many experiments on the ignition of a fine wire, and the deflection of a galvanometer. He also proves that the effects of the spark and the shock, at the moment of disjunction of a long wire, are due to a current far more powerful than that which passes through the short wire at the same instant; or indeed than that which passes through either the long or the short wire at any other instant of time than when the disjunction takes place.

That this extraordinary effect is not due to any species of inertia, is shown by the fact, that the same wire will produce it in a greater or less degree, under circumstances incapable of influencing any effect depending on inertia: thus, if 100 feet of wire, when extended, produce a certain effect, a greater effect will be produced by coiling the same wire into a helix, and a still more powerful one by employing it as the helix of an electro-magnet.

The author ultimately refers these phænomena to an inductive action of the current, analogous, or perhaps identical, with that described in the First Series of these Experimental Researches: for he found that when a second wire was placed parallel to the long conducting wire, the ends of this second wire being connected together so that a current of electricity could circulate round it, then the spark and shock did not take place at the first wire at the moment of disjunction, but a current was induced at the second wire, according to the law originally described in the First Series. The moment the current in the second wire was interrupted, the spark and shock appeared at the first. These and many other experiments were adduced to prove that these effects, namely, the shock and the spark, result from an inductive action of the original current, producing, at the moment it is stopped, a current, in the same direction as itself, in the same wire which serves to convey the original current.

The author, lastly, considers the reverse effect produced upon making contact; and concludes his paper by some general views of the consequences resulting from this inductive action in various cases of electric discharge; pointing out the important influence it must have in magneto-electrical machines of the ordinary construction.

The reading of a paper was then commenced, entitled, "Geometrical Researches concerning Terrestrial Magnetism." By Thomas Stephens Davies, Esq., F.R.S., &c.

February 12, 1835.

WILLIAM THOMAS BRANDE, Esq., Vice-President, in the Chair.

Mr. Davies's paper, entitled "Geometrical Researches concerning Terrestrial Magnetism," was resumed and concluded.

The object of this paper is to exhibit methods of conducting the mathematical inquiries which are applicable to the magnetism of the earth, by the aid of the coordinate geometry of three dimensions.

When a point on the surface of the earth is given by means of its geographical coordinates, we can also refer it to any rectilinear coordinates that may be found convenient, and the transformations of the expressions can be made by known and familiar methods. Also, since at a given point the needle is deflected a measured quantity from the meridian plane, estimated on a tangent plane to the earth at the given point, and is also depressed another measured quantity below the same plane at that given point, its position is fixed by means of these measures. It will hence become capable of reference also to the same rectilinear coordinates as those into which the geographical coordinates were transformed. The equation of the line, into which the dipping-needle disposes itself, becomes, therefore, capable of expression in terms of the measured quantities above referred to; viz., the latitude, longitude, dip, and variation. The method of obtaining the constants which enter into the "equations of the needle" as referred to the equator, a given meridian, and the meridian at right angles to it, are then detailed at length by the author; and these equations are calculated for six different places: Port Bowen, Boat Island, Chamisso Island, Valparaiso, Paris, and Paramatta.

With a view to bring the hypothesis of the duality of the centres of magnetic force to a test, the author proceeds to reason, that as a free needle subjected to the action of only two poles, will always dispose itself in the plane which passes through those poles and the centre of motion of the needle, the needle prolonged will always intersect the magnetic axis, or line which passes through the two poles. But when four straight lines are given in space, a fifth line (or rather two lines) can be so drawn as to intersect them all. If, therefore, we have the equations of four dipping-needles calculated from correct observations, we ought to be able to assign the equations of the two lines which rest upon them; one or other of which, in such case, will be the magnetic axis itself. This line ought to intersect every other needle; and hence the constants in its equations and the constants in the equations of any fifth needle ought to fulfill the algebraical test of intersection. The author has calculated the equations of the magnetic axis for the needles at Chamisso, Valparaiso, Paramatta, and Port Bowen, and made a comparison of it with the Paris needle. Instead of intersecting, the least distance between the said axis and needle is more than one 6th of the terrestrial radius; and hence, could the observations themselves be depended on, as being free from instrumental error and from local disturbances, the question of the duality of the centres of force would be at once settled in the negative; but, as the opinions of those philosophers who are best acquainted with the dipping-needle are decidedly that the dipping-needle is not yet in such a condition as to induce implicit confidence in its indications, and as, moreover, the influence of geological and meteorological sources of disturbance are yet so far unappreciated as to enable us to correct the observations for them, the author hesitates to draw any positive conclusion from the results he has obtained. However, the results thus obtained, being the direct and legitimate deductive consequences of the observations, it is of course impossible by any other course of investigations which proceeds from the same data, to draw a conclusion more to be depended on than this. The process he considers to be mathematically correct, as well as complete, and practicable; the question, as far as this test is concerned, must remain open till satisfactory data can be obtained: and he proposes at the earliest period to resume the numerical discussion of such observations as he may be able to procure.

Mr. Davies remarks, that from the great labour of the calculations, he has been led to attempt a more brief method of examination by means of carefully executed geometrical constructions; employing for that purpose the descriptive geometry, which has the advantage of bringing all the work to depend on the intersection of the hyperbola and straight line, situated upon the same plane. The resulting magnetic axes of the few cases he has constructed, though very far from coinciding, are yet positive in the same general region of the figure; and therefore the probability that their want of coincidence arises from erroneous and uncorrected observation is increased, and the importance of a more extended and careful series of observations considerably augmented.

For the purpose of examining the general character of the magnetical phænomena which ought to result from the hypothesis of the duality of the poles, Mr. Davies proceeds to investigate the formulæ which express those phænomena. These are, the magnetic equator,—the points at which the needle should become vertical,—the lines of equal dip,—the Halleyan lines, or lines of equal variation,—the isodynamic lines of Hansten,—and the points at which the magnetic intensity, compared with the points immediately contiguous in all directions, is a maximum, or in other words, where the isodynamic lines are reduced to points. The first two of these only, are treated in the present paper; the remaining ones will be the subject of a future memoir shortly to be submitted to the Society.

The mathematical processes themselves scarcely admit of verbal description; but the results of the investigation are briefly these.

When the centres of force are situated within the sphere, there will be one only, or some even number of continuous lines on the surface of the earth, at any point of which the needle will be horizontal, according as the poles be of equal or unequal intensities. Whether the magnetic equator be determined with sufficient accuracy to assure us that there is but one such line, is a matter of considerable doubt; but if it should be admitted that it is, it offers a strong confirmation of the strict analogy between the terrestrial and all other magnets with two poles, and thence an increasing confidence in all the other analogies conceived to exist between them.

The points at which the needle is vertical are given by means of two equations, one of the fifth and the other of the second degree, and hence altogether there are ten such points theoretically possible. How many of these may be simultaneously real the equations do not, in their literal form, seem capable of determining; but at all events they will, in all cases, be an even number, either 0, 2, 4, 6, 8, or 10. One having been determined, one other at least must exist in the actual circumstances of the terrestrial two-poled magnet. How many soever such simultaneous points there may be, they must all lie in the same plane; and hence, if the second point which must exist could be determined, then the great circle in the plane of which the axis of the magnet itself is situated would be determined; and thus another test would be afforded of the truth or error of the hypothesis itself. Mr. Davies suggests that as this plane will be symmetrical with respect to the phænomena taking place on each side of it, its position might be tentatively assigned from a series of observations of those phænomena, especially of the dip and intensity; the variation being for obvious geometrical reasons excluded.

Though the resulting formula does not, in its literal form, appear to be capable of decomposition into factors, yet from some considerations, chiefly analogical, Mr. Davies is led to hazard the conjecture that it is capable of such decomposition; but as this is uncertain, he builds no consequences upon it, but leaves those consequences which would flow from it, open till it shall be discovered whether they would be justified by the conjecture itself being proved to be correct.

A paper was also read, entitled, "On certain Peculiarities in the double Refraction, and Absorption of Light, exhibited in the Oxalate of Chromium and Potash." By Sir David Brewster, K.H., L.L.D., F.R.S.

The crystals of the oxalate of chromium and potash are, generally speaking, opake; for at thicknesses not much greater than the 25th of an inch, they are absolutely impervious to the sun's rays, and their colour, seen by reflected light, is nearly black; but when powdered, they are green; and the colour of the smaller crystals, viewed either by reflected or by transmitted daylight, is blue. One of the most remarkable of the properties of this salt is the difference of colour in the two images formed by double refraction. At a certain small thickness, the least refracted image is bright blue, and the most refracted image bright green. The blue is found by analysis with the prism to contain an admixture of green, and the green an admixture of red; and by candlelight this red predominating over the green, gives the crystal a pink hue. At greater thicknesses the blue becomes purer and fainter, and the green passes into red; and at a certain thickness the least refracted blue image disappears altogether, and the most refracted image is alone seen. At still greater thicknesses this image also disappears, and absolute opacity ensues. When the crystal is exposed to polarized light, with its axis in the plane of polarization, the transmitted light is green; but when the axis is perpendicular to that plane, the transmitted light is blue. A solution of the salt exhibits the same general action upon light as the solid, with the exception of double refraction. This salt has also the peculiar property of exciting a specific action upon a definite red ray, situated near the extremity of the red portion of the spectrum.

February 19, 1835.

Sir JOHN RENNIE, Knt. Vice-President, in the Chair.

A paper was read, entitled, "On the probable Position of the South Magnetic Pole." By Edward Rudge, Esq., F.R.S., &c.

The recent discovery of the site of the North Magnetic Pole, which has resulted from the experiments of Capt. James Ross, suggested to the author the inquiry whether any similar indications of an approach to the South Magnetic Pole can be gathered from any observations now on record. With this view a table is given of the observations made by Tasman in 1642 and 1643, during his voyage of discovery in the Southern Ocean, extracted from his journal; from which it appears that he on one occasion noticed the continual agitation of the horizontal needle, in south latitude 42° 25′, and longitude from Paris 160°. On the presumption that the South Magnetic Pole was at that time near this spot, and that it has since been retrograding towards the East, the author conjectures that it will now be found in or about the 43rd parallel of south latitude; and to the south-east of the Island of Madagascar, a situation extremely convenient for ascertaining its exact position, which he considers as an object of great theoretical as well as practical importance.

The reading of a paper was then commenced, entitled, "An Experimental Inquiry into the Cause of the grave and acute Tones of the Human Voice." By John Bishop, Esq. Communicated by P. M. Roget, M.D., Sec. R.S.

February 26, 1835.

JOHN WILLIAM LUBBOCK, Esq., Vice-President and Treasurer, in the Chair.

The reading of a paper, entitled, "An Experimental Inquiry into the Cause of the grave and acute Tones of the Human Voice." By John Bishop, Esq. Communicated by P. M. Roget, M.D., Secretary to the Royal Society, was resumed and concluded.

The author considers all the theories hitherto proposed respecting the functions of the organs of the human voice, as not only unsatisfactory, but as being founded on erroneous views. He shows that the modulation of the tones of the voice is not the result of variations either exclusively in the length or in the tension of the vocal chords, or in the size of the aperture of the glottis, or in the velocity or the temperature imparted to the air in its transit through these passages. He regards the organs of the voice as combining the properties of wind and of stringed musical instruments; and shows, first, that for the production of any musical tone it is necessary that the vocal chords should previously be made mutually to approximate; and, secondly, that the muscular forces acting on the arytenoid cartilages and vocal chords are adequate not only to resist the pressure of the column of air issuing from the lungs, but also to render either the whole or certain portions of the vocal chords susceptible of vibration when traversed by the current of respired air. In proportion as these parts of the vocal chords, thus rendered vibratory, increase in length, the number of their vibrations, performed in a given time, diminishes, and the tone of the sound emitted becomes, in consequence, more grave; and, conversely, the tone is more acute as the vibrating portions of the chord are shorter: these phænomena being precisely analogous to those which take place in stringed musical instruments.

The author concludes his paper with some observations on the comparative physiology of the voice; and on the extensive range and superior excellence of this faculty in man.

The following letter was read;

British Museum, February 26th, 1835.

My Dear Sir,

I am commanded by His Royal Highness the President of the Royal Society to request that you will state from the Chair, at the close of this evening's meeting, how sincerely His Royal Highness regrets that, in consequence of the opinion of Dr. Maton and his other medical advisers, he is obliged, *for the present*, to forego the pleasure, so truly gratifying to himself, of holding the usual Soirées at Kensington Palace. His Royal Highness, however, hopes that, by the blessing of Providence, he may yet have the satisfaction of receiving the Fellows as heretofore, before the termination of the present Session.

I am ever, my dear Sir, faithfully yours,
John George Children, Sec. R. S.

John William Lubbock, Esq.
V. P. and Treas. R. S.

March 5, 1835.

Sir BENJAMIN COLLINS BRODIE, Bart., Vice-President, in the Chair.

A paper was read, entitled, "A new Method of discovering the Equations of Caustics." By G. H. S. Johnson, M.A., Tutor of Queen's College, Oxford. Communicated by the Rev. Baden Powell, M.A., F.R.S.

Peculiar difficulty has hitherto attended the determination of the equation of the curve formed by the perpetual intersection of rays, which, diverging from a luminous point, are reflected by a polished surface of a given curvature. Curves of this description have been denominated caustics; and the method usually employed to discover their polar equations, or the relation between the radius vector of any point of the curve and the tangent at that point, is both long and inelegant, and is considered by the author as involving considerable inaccuracy of reasoning. He proposes, therefore, to substitute a new method of investigation, by taking the polar equation of one of the reflected rays, and differentiating this equation with respect to the arbitrary quantities solely which determine its position, and thus obtaining the polar co-ordinates of the point of intersection of two consecutive lines; and finally, by elimination, the equation of the curve in which all such points are found. He is thus led to results remarkable for their simplicity, elegance, and generality: and he gives particular applications of his method, exemplifying the facility with which it effects the solution of problems extremely difficult of management by the ordinary methods hitherto employed. His method is also applicable to the determination of the equations of the evolutes of curves, and to various other problems of a similar nature.

A paper was also read, entitled, "Discovery of the Metamorphoses in the second Type of the Cirripedes, viz. the *Lepades*, completing the Natural History of these singular Animals, and confirming their affinity with the Crustacea." By J. V. Thompson, Esq., F.L.S., Deputy Inspector General of Hospitals. Communicated by Sir James Macgrigor, Bart., M.D., F.R.S.

The discoveries made by the author of the remarkable metamorphoses which the animals composing the first family of the Cirripedes, or *Balani*, undergo in the progress of their developement, and which he has published in the third number of his Zoological Researches (p. 76), are in the present paper, which is intended as a prize Essay for one of the Royal Medals, followed up by the report of his discovery of similar changes exhibited by three species of two other genera of the second tribe of this family, namely, the *Lepades*. The larvæ of this tribe, like those of the Balani, have the external appearance of bivalve Monoculi, furnished with locomotive organs, in the form of three pairs of members, the most anterior of which are simple and the other bifid. The back of the animal is covered by an ample shield, terminating anteriorly in two extended horns, and posteriorly in a single elongated spinous process. Thus they possess considerable powers of locomotion, which, with the assistance of an organ of vision, enable them to seek their future permanent place of residence. The author is led from his researches to the conclusion that the Cirripedes do not constitute, as modern naturalists have considered them, a distinct class of animals, but that they occupy a place intermediate between the Crustacea decapoda, with which the Balani have a marked affinity, and the Crustacea entomostraca, to which the Lepades are allied; and that they have no natural affinity with the Testaceous Mollusca, as was supposed by Linnæus, and all the older systematic writers on Zoology.

March 12, 1835.

The Rev. PHILIP JENNINGS, D.D., Vice-President, in the Chair.

Continuation of a former paper "On the twenty-five feet Zenith Telescope, lately erected at the Royal Observatory;" by John Pond, Esq., F.R.S., Astronomer Royal.

For determining the place of any star passing the meridian near the zenith, at the Royal Observatory at Greenwich, three different methods may be employed: first, by means of the mural circles; secondly, by the zenith telescope, used alternately east and west; and lastly, by means of a small subsidiary angle, as described by the author in a former paper. The details of computations made according to each of these three methods are contained in the present paper; from which it appears that they all give results nearly identical; and that, when the observations with the two circles are made with sufficient care, the greatest error to be apprehended does not exceed the quarter of a second.

"Remarks towards establishing a Theory of the Dispersion of Light." By the Rev. Baden Powell, M.A., F.R.S., Savilian Professor of Geometry in the University of Oxford.

In an abstract of M. Cauchy's Theory of Undulations, published in the London and Edinburgh Journal of Science, the author of the present paper deduced a formula expressing precisely the relation between the length of a wave and the velocity of its propagation; and showed that this last quantity is, in fact, the same as the reciprocal of the refractive index. The author here examines, by means of this formula, the relation between the index of refraction and the length of the period, or wave, for each definite ray, throughout the whole series of numerical results which we at present possess; and the conclusion to which he arrives from this comparison, for all the substances examined by Frauenhofer, viz. for four kinds of flint glass, three of crown glass, water, solution of potash, and oil of turpentine, is that the refractive indices observed for each of the seven definite rays are related to the length of waves of the same rays, as nearly as possible according to the formula above deduced from Cauchy's theory. For all the media as yet accurately examined, therefore, the theory of undulations, as modified by that distinguished analyst, supplies at once both the law and the explanation of the phenomena of the dispersion of light.

March 19, 1835.

Sir JOHN RENNIE, Knt., Vice-President, in the Chair.

A paper was read, entitled, "Some Account of the Eruption of Vesuvius, which occurred in the month of August, 1834, extracted from the manuscript notes of the Cavaliere Monticelli, Foreign Associate of the Geological Society, and from other sources; together with a Statement of the Products of the Eruption, and of the Condition of the Volcano subsequently to it." By Charles Daubeny, F.R.S., F.G.S., and Professor of Chemistry in the University of Oxford.

It appears, from the information collected by the author, that for a considerable time previously to the late eruption of Vesuvius, stones and scoriæ had been thrown up from the crater, and had accumulated into two conical masses, the largest of which was more than two hundred feet in height. On the night of the 24th of August last, after the flow of considerable currents of lava, a violent concussion took place, followed by the disappearance of both these conical hillocks, which, in the course of a single night, were apparently swallowed up within the cavities of the mountain. Fresh currents of lava continued to flow for several days subsequently, destroying about 180 houses, spreading devastation over a large tract of country, and destroying all the fish in the neighbouring ponds and lakes. After the 29th of August, no further signs of internal commotion were manifested, with the exception of the disengagement of aqueous and aëriform vapours from the crater, a phenomenon which, in a greater or less degree, is at all times observable. The author descended twice into the interior of the crater, which then presented a comparatively level surface; its sides consisting of strata of loose volcanic sand and rapilli, coated with saline incrustations of common salt, coloured red and yellow by peroxide of iron. The vapours which issued from various parts of the surface, collected and condensed by means of an alembic, introduced into the ground, were found to consist principally of steam and muriatic acid, with only a slight trace of sulphureous or sulphuric acids. From a trial with solution of barytes, the author concludes that carbonic acid was also exhaled, but neither nitrogen nor sulphuretted hydrogen appeared to form any part of the gas emitted. The steam issuing from the lava contained both free muriatic acid and also muriate of ammonia, which latter salt could not be detected in the gas from the volcano itself. The author conceives that these volatile principles are entangled in the lava, and are subsequently disengaged.

March 26, 1835.

WILLIAM THOMAS BRANDE, Esq., Vice-President, in the Chair.

"On the Temperature of some Fishes of the Genus Thunnus." By John Davy, M.D., F.R.S., Assistant Inspector of Army Hospitals.

The author had occasion to observe, many years ago, that the Bonito (*Thynnus pelamys*, Cuv.) had a temperature of 99° of Fahr. when the surrounding medium was 80°·5, and that it, therefore, constituted an exception to the generally received rule that fishes are universally cold-blooded. Having found that the gills of the common Thunny of the Mediterranean (*Thynnus vulgaris*, Cuv.) were supplied with nerves of unusual magnitude, that the heart of this latter fish was very powerful, and that its muscles were of a dark red colour, he was led to conjecture that it might, like the Bonito, be also warm-blooded; and this opinion is corroborated by the testimony of several intelligent fishermen. The author endeavours to extend this analogy to other species of the same family, which, according to the reports of the fishermen of whom he made inquiries, have a high temperature, and in whose internal structure he noticed similar peculiarities as in the Thunny; namely, very large branchial nerves, furnished with ganglia of considerable size. In this respect he considers that in these fishes the branchial system of organs makes an approximation to the respiratory apparatus of the Mammalia, and that it probably contributes to the elevation of temperature, resulting from the more energetic respiration which he supposes to be exercised by these organs. He, however, thinks it not improbable that these fish may possess means of generating heat peculiar to themselves, and of which at present we have no adequate idea. He conceives that the situation of the kidneys, of which a considerable portion is even higher than the stomach, and posterior to the gills, and which are of large size, and well supplied with nerves and blood-vessels, may possibly act a part in the production of an elevated temperature; but, on the whole, he is disposed to ascribe the greatest share of this effect to the superior magnitude of the branchial nerves.